# Repeat Microgravity Monitoring of Rio Grande River Seepage and Groundwater Withdrawals in the Mesilla Valley, New Mexico

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Increasing water demand for public supply and irrigation coupled with limited surface-water supplies have resulted in increased groundwater withdrawals in the Mesilla Basin in south-central New Mexico. In 1987, the U.S. Geological Survey established the Mesilla Basin Monitoring Program in cooperation with several federal, state and local agencies to document the hydrologic conditions within the basin and to create a long-term database to permit the quantitative evaluation of the groundwater-flow system and stream-aquifer relations.

As part of the monitoring program a pilot microgravity study was carried out with two to three surveys per year at 20 stations from 2016 to 2018. The network of gravity stations was designed to identify recharge occurring through a losing reach of the Rio Grande River, with additional monitoring near a reach where recharge was not expected. Other stations were placed in agricultural areas, and the timing of the monitoring was designed to detect changes due to annual patterns of pumping for irrigation. Where feasible, gravity stations were collocated with wells to enable estimates of specific yield.

By precisely measuring the change in the acceleration due to gravity through time, it is possible to estimate the change in groundwater storage underneath the gravity meter through a simple linear relation (4.2 x 10-7 m/s2 equals 1 m of free-standing water). This relation is independent of the depth to water or porosity of the aquifer. Closely-spaced stations allow the total volume of groundwater-storage change to be interpolated. Furthermore, if gravity stations are collocated with monitoring wells, the relation between storage change (derived from gravity data) and groundwater-level change can be used to estimate specific yield. Changes in storage measured using repeat microgravity represent a 1-dimensional thickness of free-standing water; the equivalent change in groundwater level is the storage change divided by the specific yield

Overall, changes in gravity corresponded with the irrigation regime, with increases in groundwater storage of up to 0.52 m observed during the summer season and decreases of up to 0.64 m during other parts of the year. Most sites collocated with wells showed good correlation between gravity-derived changes in storage and changes in groundwater levels, resulting in estimates for specific yield ranging from 0.17 to 0.34. At five sites, storage changes were insufficiently small to estimate specific yield.

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